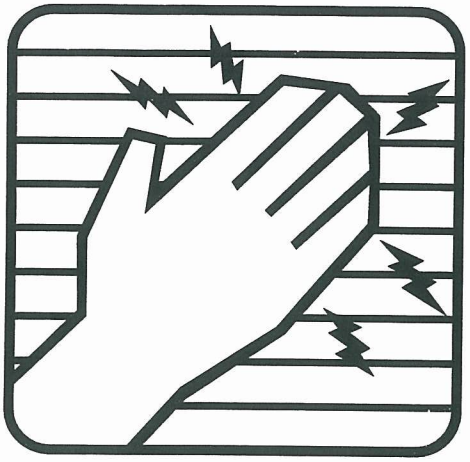
A Physicist's View of the Use of



Feeble Electric Direct Currents

To Repair Tissue and Replace Body Parts

Part One

By Gary Wade

In this article I am going to give a review of the essential aspects and results of Dr. Robert Becker's research group and the work of others, as was laid out in his book, *The Body Electric* which will supply the solid foundation needed to support a simple yet critical observation, which explains how, in general, to regenerate mammal body tissues, including the spinal cord.

Mammals are lacking a single simple tissue electric direct current "code", which would allow them to repair server tissue damage such as an amputation. After severe tissue damage in mammals, all of the other needed biological repair processes are ready and just waiting for this electric direct current code. Complete tissue repair or replacement would then come as a natural course of events, following this direct current code. This direct current code can be simply and easily artificially supplied after severe damage or after surgically removing the scar tissue at an old amputation site. This direct current generates a physical chemistry process which has the net result of significantly increasing above normal the positive metal ion concentrations, lowering hydrogen ion concentration (higher PH), and decreasing the negative chlorine ion concentration below normal in the saline plasma solution outside the cell membranes in the damaged tissue. These much higher positive ion concentrations and lower than normal chlorine ion concentrations in combination with nerve cell and other cell hormone secretions foster tissue repair and/or replacement. Though the direct current regeneration code can be simply and easily implemented in practice, the current allopathic medical system is not likely to implement it. The people who need this regeneration process will probably have to light a "fire" under the hind quarters of allopathic medicine's ignorant, arrogant, complacent, and corrupt leadership.

Some years ago I read the book *The Body Electric* by Robert O. Becker, M.D., and Gary Selden.[1] For me it was a fascinating book for it dealt with many of the electrical aspects of biology, in which I have a keen interest. Shortly after reading Becker's book, my sister informed me that a dear friend of hers had become a quadriplegic as a result of a gun shot to his neck. The perpetrator of this act had been apprehended shortly after the shooting. It was learned that it had been a case of mistaken identity. This hired killer had mistaken Richard for his intended target. Because of Richard's tragic situation, I decided to see if there was something I could do about spinal cord damage and breakage. To do this, I would have to figure out the secret to repairing/replacing body tissue in mammals. Becker and his associates had essentially done all the needed experimental work, as was clearly laid out in his book *The Body Electric*. What was required was someone to put all the pieces together into a coherent approach to regeneration, which explained what was the critical factor to get tissue regeneration or replacement. Becker and his fellow researchers had even effectively done this. They had only failed to recognize a positive ion increasing concentration process, an increasing PH process, and a decreasing negative chlorine ion concentration process caused by the direct current which triggers cell dedifferentiation in certain cell types necessary for beginning the tissue regeneration process.

Figure 1A crudely illustrates the anatomy of the nervous system of the salamander. Even though there is a great

Continued

Use of Feeble Electric Currents

Continued

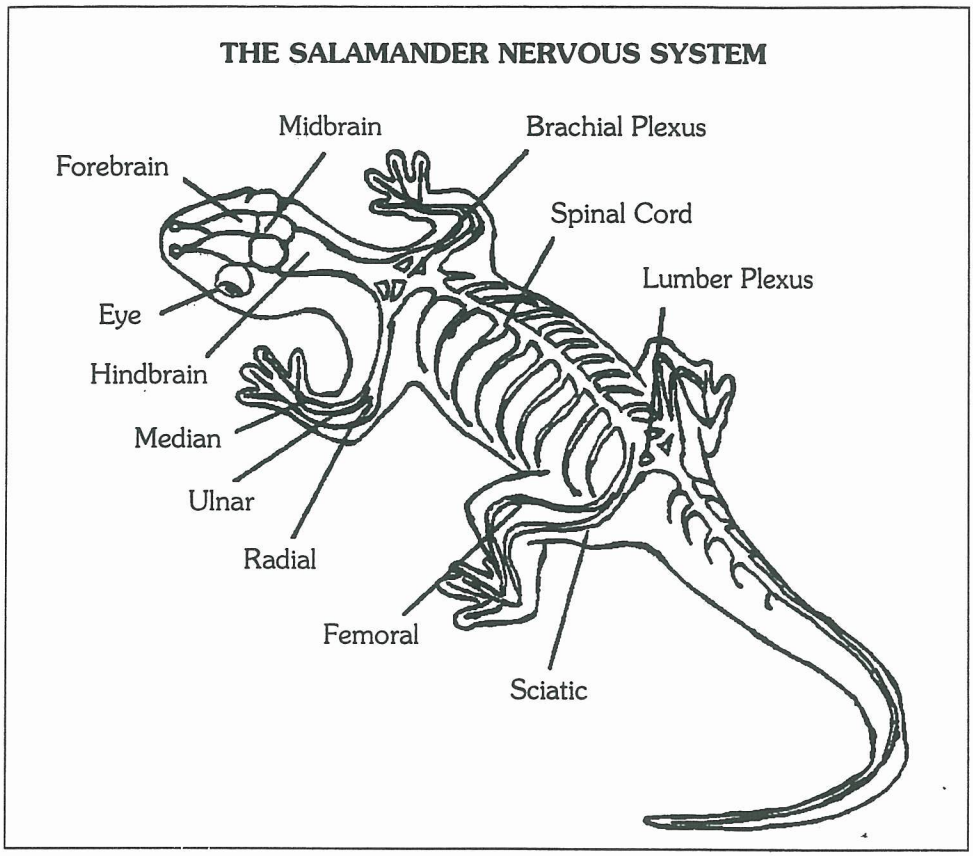


Figure 1A

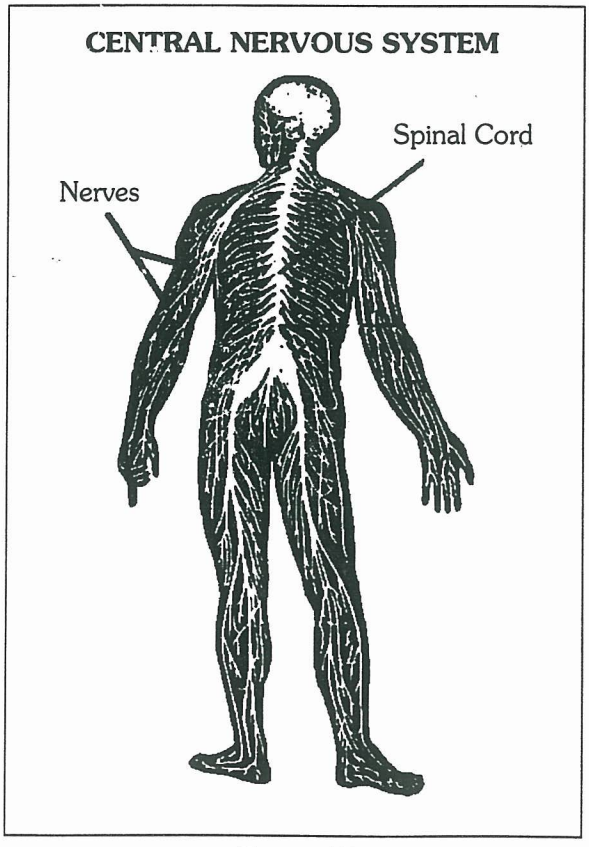


Figure 1B

deal of difference in the fine details between a salamander's nervous system and that of a mammal, it can still be thought of as a forerunner to ours (see Figure 1B). And, in fact, there is one critical similarity between salamander and mammal nervous systems which is critical for regeneration of damaged tissue. That similarity is that both nervous systems have Schwann type cells which surround motor nerve axons and sensor nerve fibers, which also transport direct electric currents to and from body tissue (see Figures 1C and 1D). The Schwann cells coating the motor nerve fiber axon carry negative charges (electrons) away from the central nervous system and deposit them into body tissue in the form of hydroxyl ions (OH^-). The Schwann cells coating the sensor nerve fibers carry negative charges (electrons) away from the body tissue (mainly surface tissue) back into the central nervous system tissue. As we proceed in this article, it will become clear how these currents are critical to regeneration. The key physiological difference for us to note in the nervous system anatomy between a salamander and a mammal is that a salamander has approximately three to four times more nerve tissue mass per unit volume of tissue when considering tissue

Continued

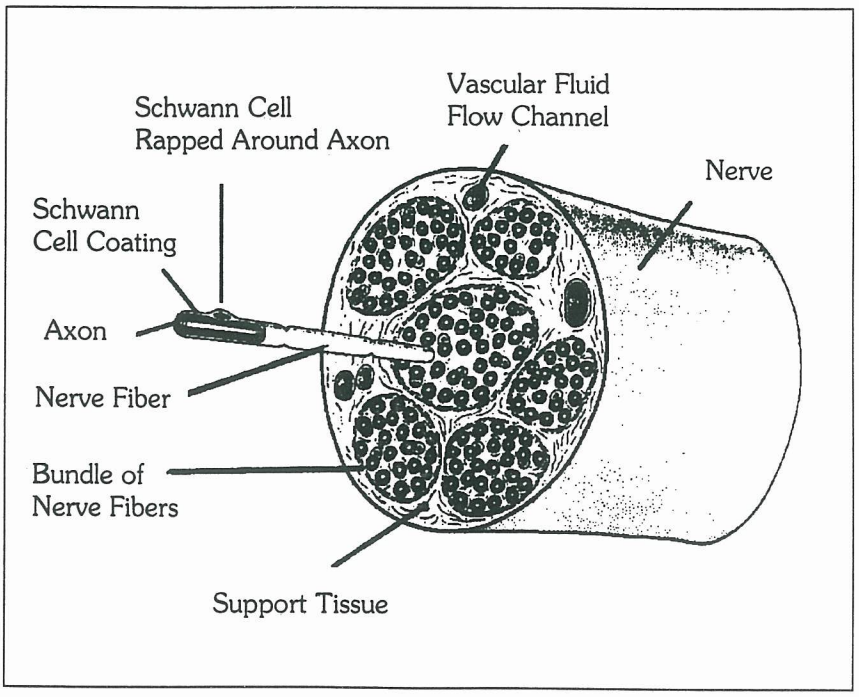


Figure 1C

Use of Feeble Electric Currents

Continued

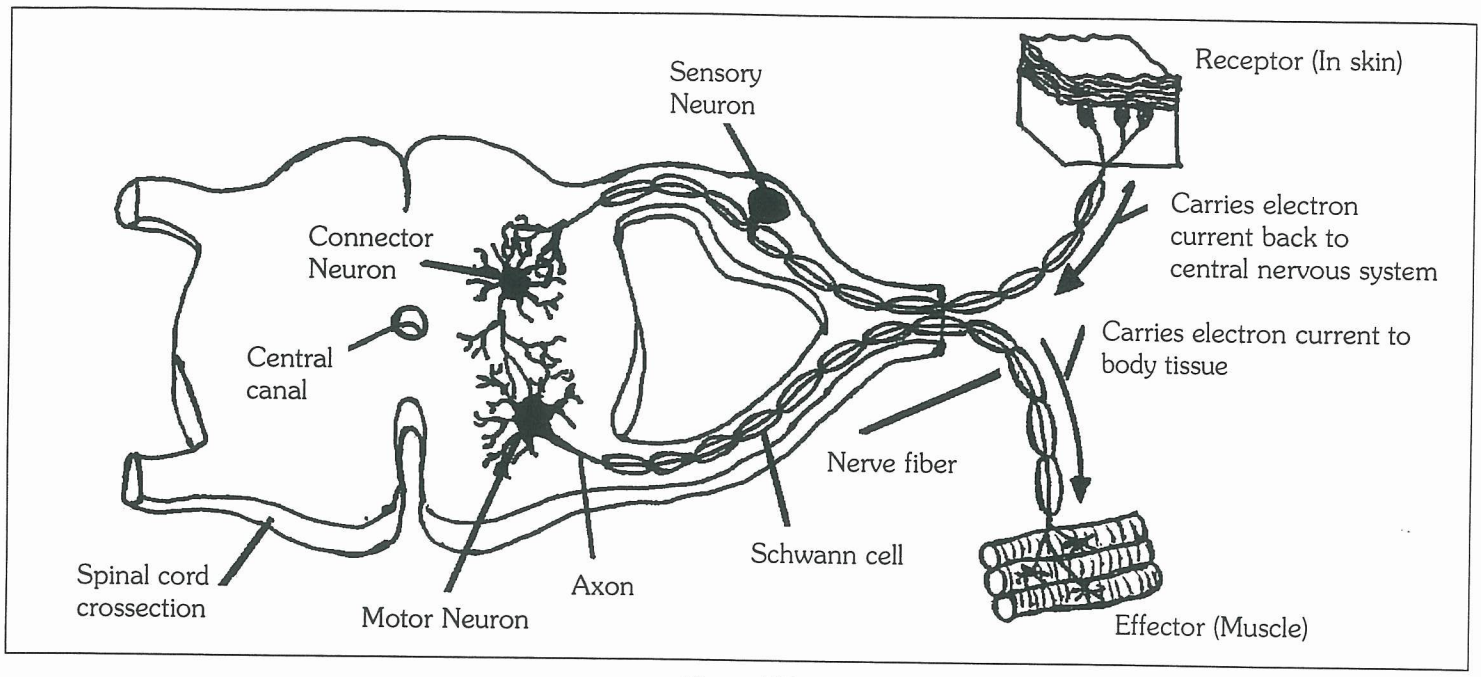


Figure 1D

outside the central nervous system. This means that salamanders have potentially approximately three to four times more current transporting ability to and from their tissue.[2] However, it is the basic similarities between the salamander and mammal nervous systems which initially gave hope, that was later experimentally verified, that a mammal could regrow body parts, just as a salamander could. It is the astounding regeneration abilities of salamanders that have kept some researchers so hopeful for mammals (humans) to be able to some day regenerate body tissue and parts throughout the entire body, if only the salamander's secret could be learned. Salamanders can regrow their arms, legs, tails, half a heart (after surgical removal), repair a cut or severed spinal cord, regrow a removed eye, and regrow large amounts of their brain (after surgical removal).

Figure 2 illustrates the qualitative distribution and polarity of the voltage found on the skin surface of the salamander. The negative areas have a very slight surplus of electrons and the positive areas a very slight deficiency of electrons. Figures 3A and 3B illustrate how the relative voltage changes with position on the legs and arms on a salamander's body relative to the voltage potential at the reference points, the lumbar plexus and brachial plexus respectfully. In Figure 3B, the reference voltage has arbitrarily been set to zero for graphing purposes.

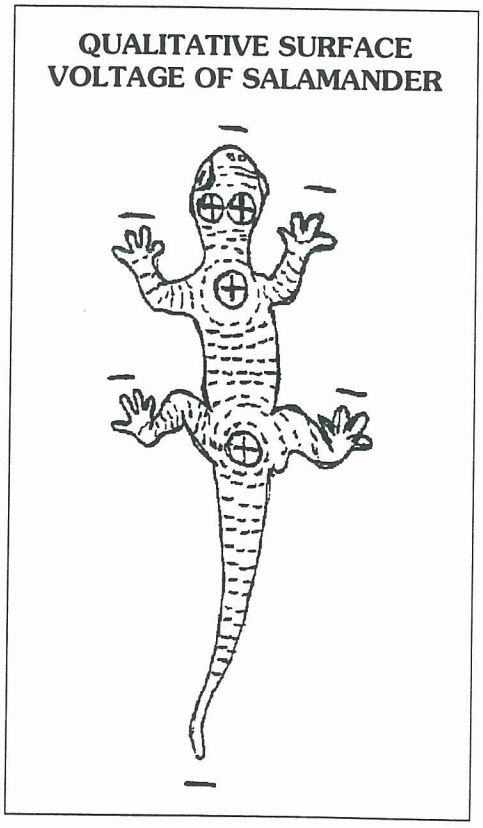


Figure 2

Figure 4 illustrates a sponge soaked in salt water mockup of a salamander, which Becker made.

His idea was to consider a salamander's body essentially a saline

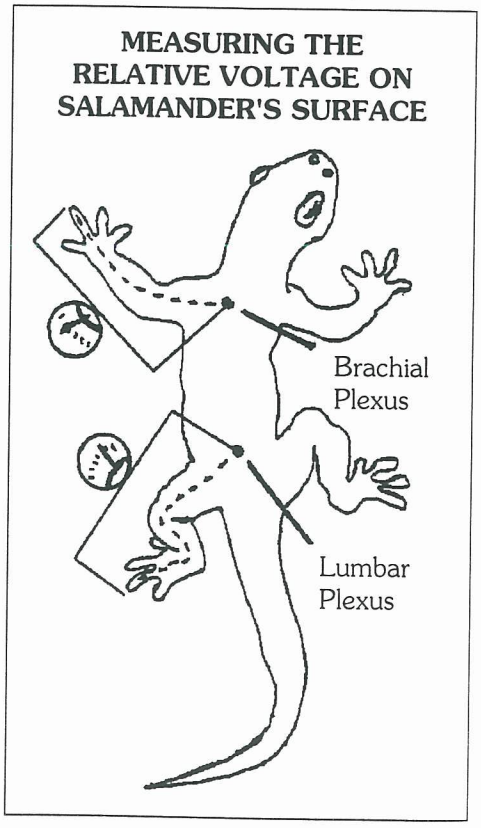


Figure 3A

Use of Feeble Electric Currents

Continued

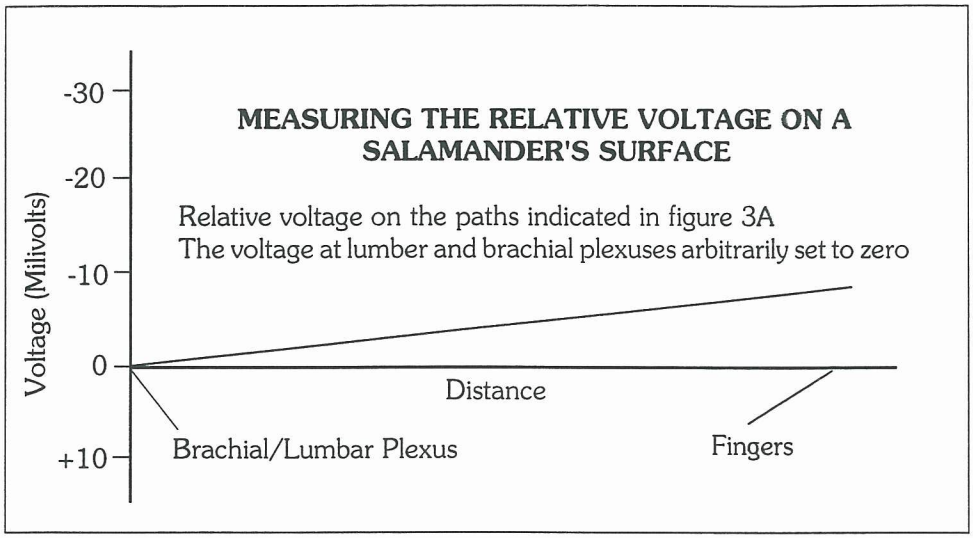


Figure 3B

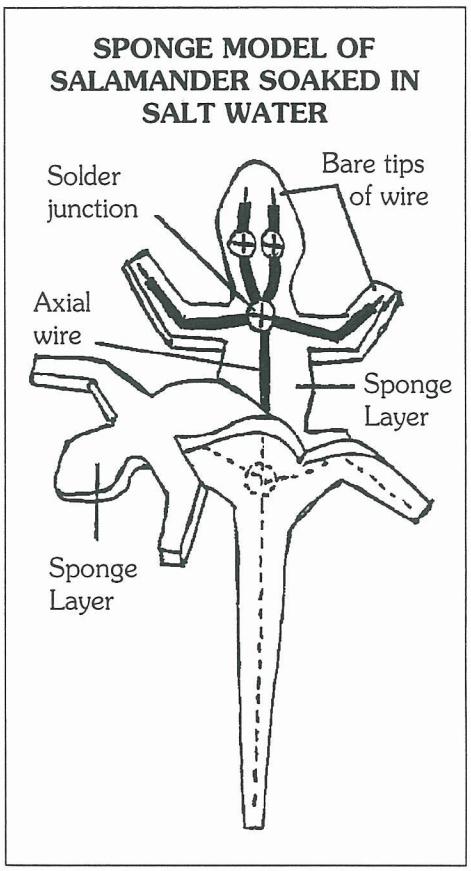


Figure 4

solution with current sources imbedded in it. Becker used the contact potential difference between two dissimilar metals (copper and solder), along with their electrochemical potential differences to supply the driving voltage which supplied a weak electric current in the salt water solution of the salamander mockup. The copper charges up negative when in contact with solder (lead and tin alloy),

Use of Feeble Electric Currents

Continued

and the solder charges up positive. The electrically conductive salt solution completes the circuit between the exposed copper and solder electrodes shown in Figure 4. Positive ions of lead (Pb^{++}) and tin (Sn^{++}) "dissolve" into the salt solution along with chlorine gas generation and minor positive hydrogen ion generation and molecular oxygen generation at the positive solder electrode. Negative hydroxyl ions (OH^-) and neutral hydrogen atoms/molecules are generated at the negative copper electrode. When Becker measured the voltage distribution on his mockup, he got the same polarity and qualitative voltage readings he got from real salamanders. This qualitatively verified his idea that a salamander had direct current electricity flowing in its body and that these currents may be the key to the salamander's ability to regenerate from massive tissue damage, such as an amputation.

Figure 5A illustrates the regrowth/regeneration process a salamander goes through after its arm is amputated just above the elbow. Figure 5B illustrates how the voltage potential at the wound/amputation site relative to the reference point (brachial plexus) potential, arbitrarily set to zero, changes with time as the wound site changes into a blastema and grows into a new arm. The final voltage reading on Figure 5B is from the new fingers. It is the salamander's Schwann cells which supply the observed voltage/current changes associated with regeneration. The relative voltage increase at the amputation site indicates a similar increase in negative current being delivered to the wound area. Becker performed experiments[3] which showed that the current carrier in the Schwann cell coating is a N-type semiconductor. The N-type semiconductor is presumably the triple-stranded protein collagen, which is used by the body for cohesion between cells and which is also a known N-type semiconductor.

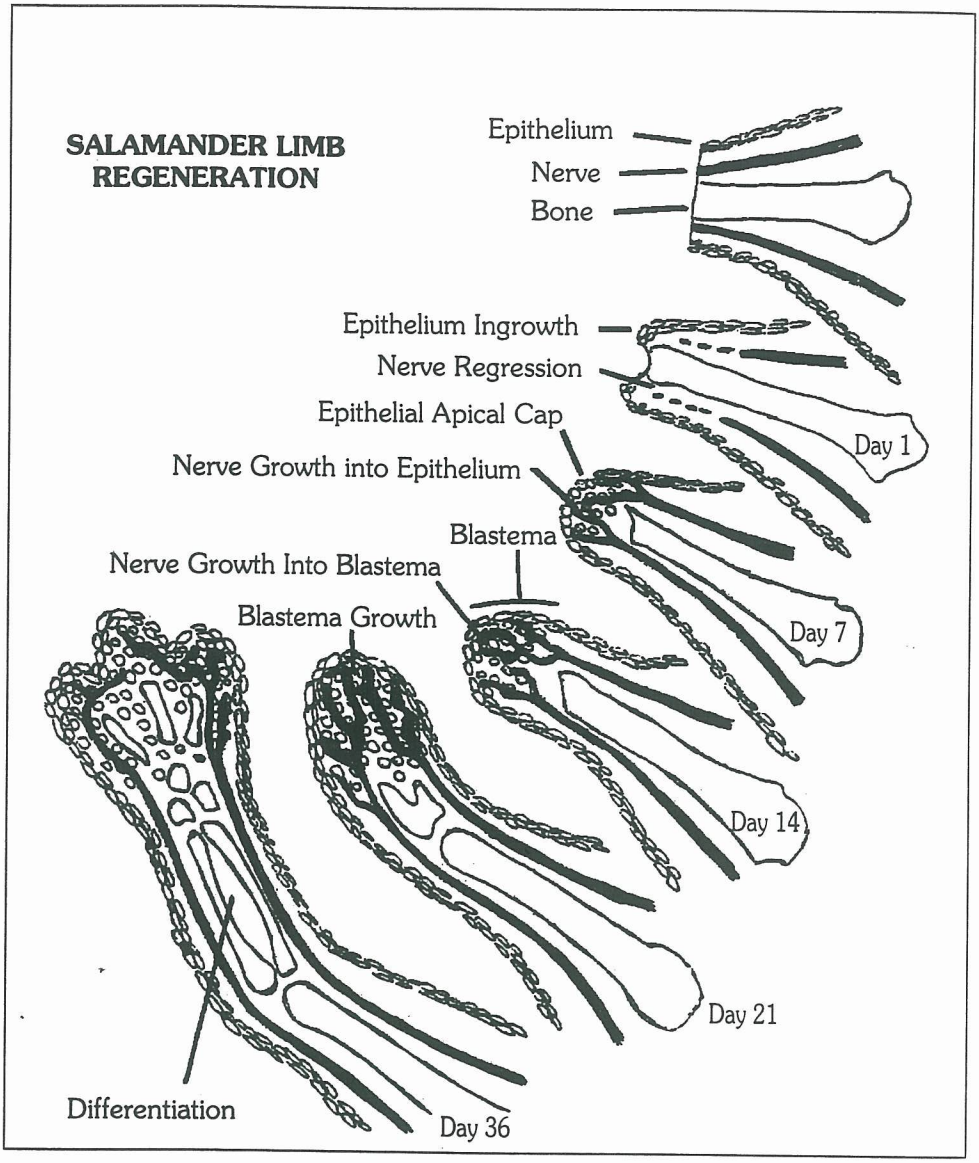


Figure 5A

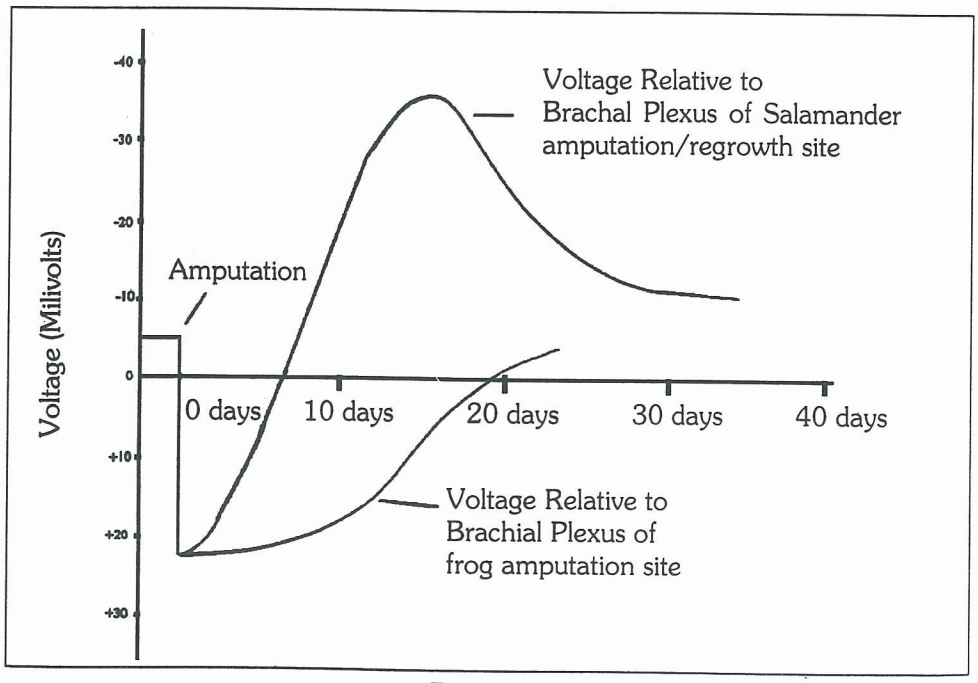


Figure 5B

Use of Feeble Electric Currents

Continued

A key experiment performed by Becker's research team on frog red blood cells gives the key information to answer the question: How can cells dedifferentiate from a specific functional cell type such as a blood cell type into primitive embryonic looking cells of the blastema. These blastema cells then divide/multiply and then differentiate under the direction/control of nerve cell hormone secretions and adjacent cell hormone secretion into all the cell types needed to form the reforming arm tissue after amputation, as is illustrated in Figure 5A. Figure 6A and 6B illustrate Becker's key experiment carried out on frog red blood cells.[4] Frog and salamander red blood cells, unlike mammal red blood cells, still have their cell nucleus containing a complete copy of the frog or salamander genetic material (the chromosomes). The salamander red blood cells are the main target cells that the salamander uses to form the embryonic primitive cells of the blastema. In mammals the target cells used for forming the primitive looking dedifferentiated cells of the blastema are apparently mainly macrophages, the fibroblast cells, Schwann cells, bone marrow cells and glia and ependymal cells in spinal cord repair. Observing frog red blood cells with a microscope, while exposing them to different values of minute direct current flow in their surrounding saline medium (Ringer's solution), the frog red blood cells change into primitive embryonic looking cells. In Becker's particular experimental set up (illustrated in Figure 6A) he found current flows between 200 and 700 picoamps (10^{-12} amps) caused red blood cells to dedifferentiate into primitive embryonic looking cells. First the blood cells at the negative electrode dedifferentiated, then at the positive electrode, and then spreading across the rest of the chamber. Within a few hours all the blood cells had become completely unspecialized, lost their hemoglobin and their nuclei had reactivated.

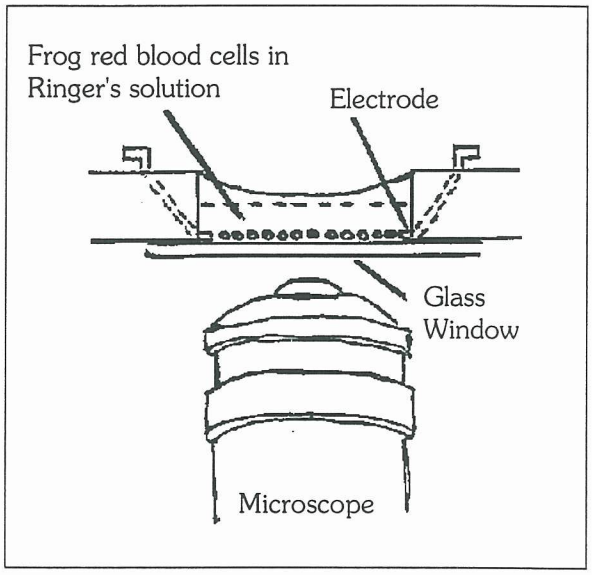


Figure 6A

Since the direct current in the saline solution cannot flow through the red blood cell interiors due to their bi-lipid cell membranes acting as insulators, Becker's group proposed an interaction between the direct current and the cell

Continued

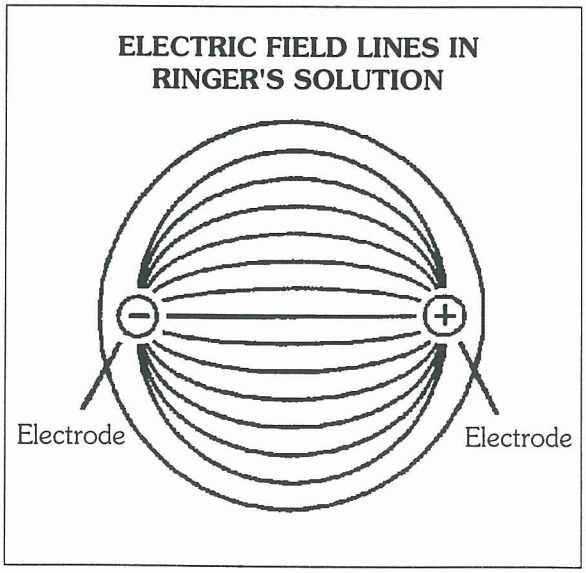


Figure 6B

Use of Feeble Electric Currents

Continued

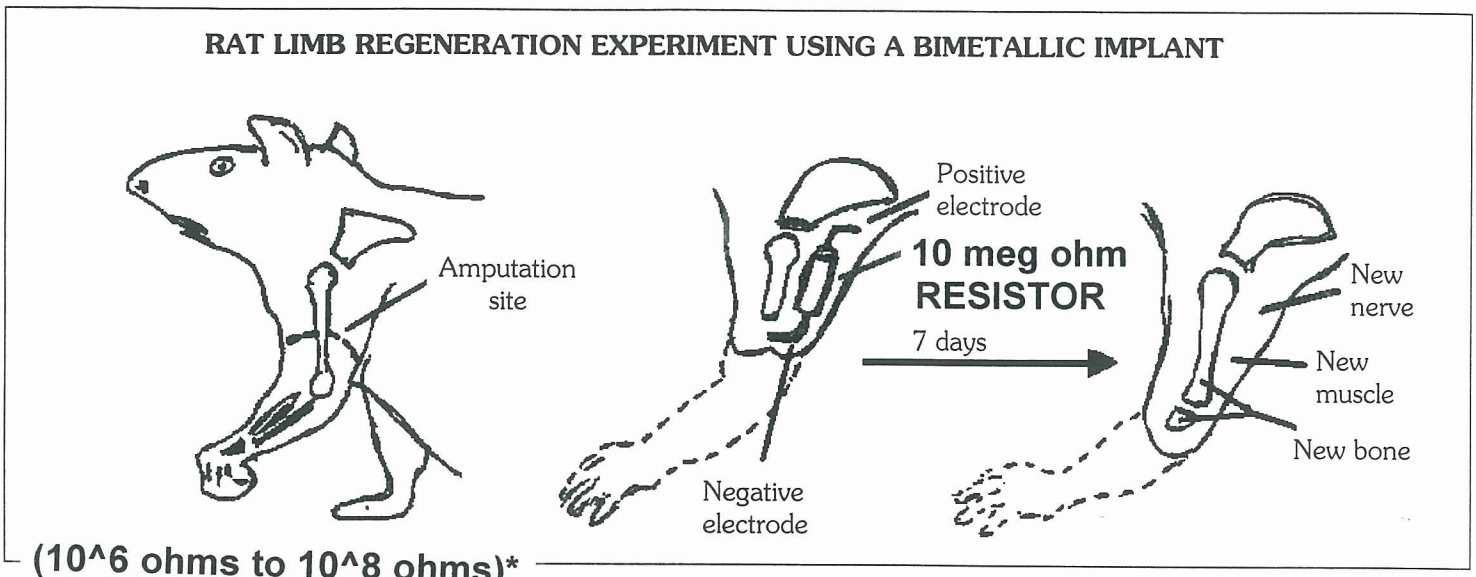


Figure 7A

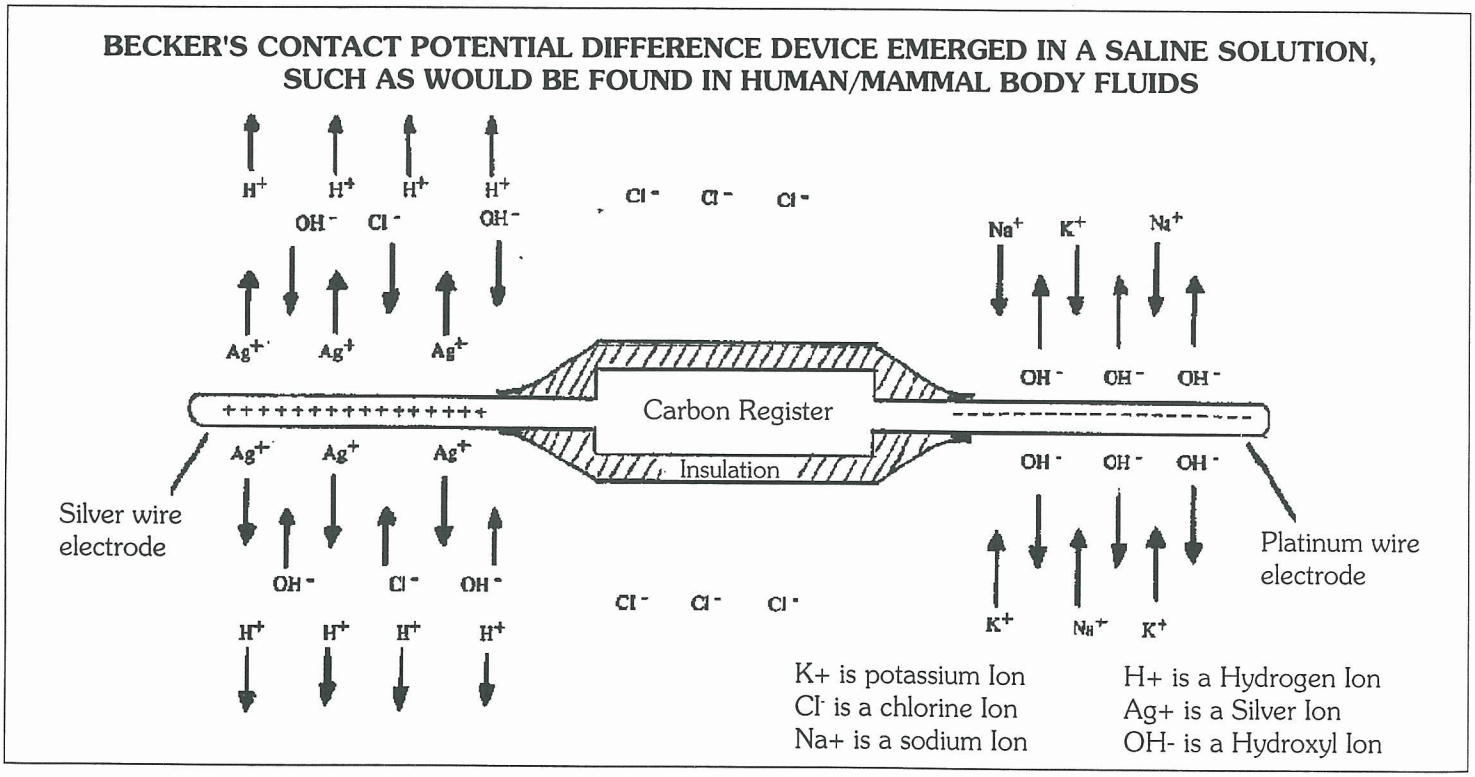


Figure 7B

membrane which released derepressor proteins on the inside of the cell membrane which derepressed genes and allowed or made the cell dedifferentiate into a primitive looking cell type. This hypothesis however does not explain: 1) Why only a narrow minuscule direct current flow range (a current window) works to dedifferentiate cells, 2) Why the dedifferentiation starts first at the negative electrode region and then the positive electrode region and then to be followed through out the entire chamber.

I am going to propose a similar but different hypothesis as to why minuscule current flow can cause cells to dedifferentiate. Becker's successful experiment to partially regrow a amputated rat arm using a implanted negative current source, will be used to illustrate my hypothesis. Figure 7A illustrates Becker's partially successful experimental attempt to regrow a rat's amputated forearm. From

Continued

*** Post publication note: Becker got positive results with the resistance value in this range.**

Use of Feeble Electric Currents

Continued

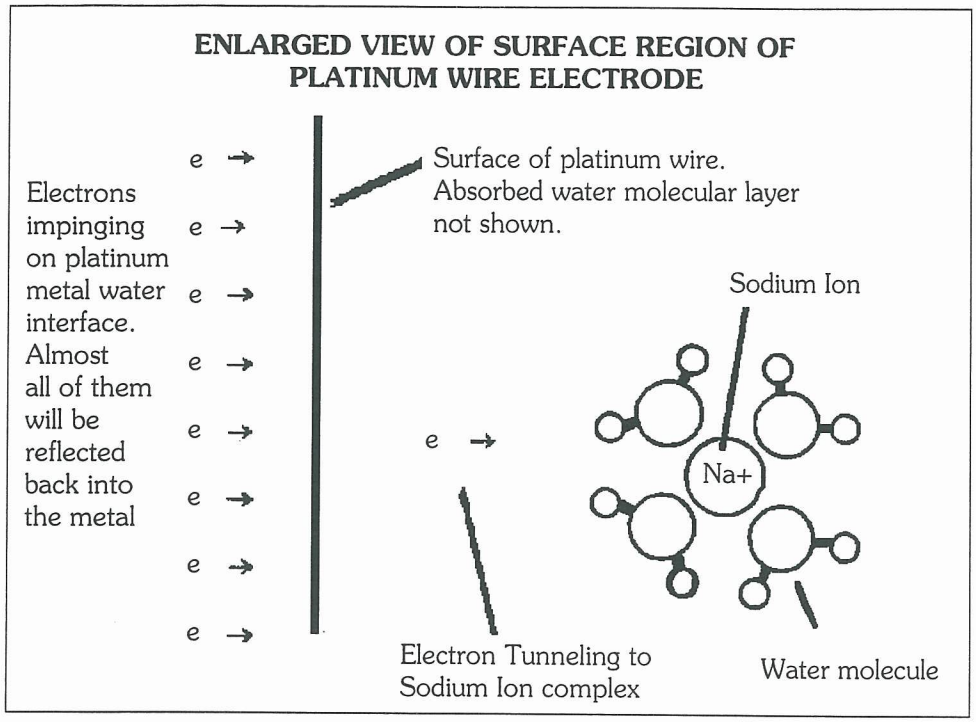


Figure 7C

experimental data gained from observing salamanders regrow amputated limbs, Becker was able to estimate the amount of "negative" direct current flow needed at the amputation site on a rat's arm to form a blastema and to obtain regeneration or regrowth of the arm. Becker used the contact potential difference between two dissimilar metals to supply the needed direct current flow. This direct current flow would now be flowing in the saline body fluids of the rat. The two dissimilar metals were platinum and silver with a carbon high ohmage resistor connected between them to control the amount of current flow produced. The device formed this way and illustrated in Figure 7B was implanted in the rat arm with the negative electrode placed just behind the amputation site where the blastema is to form. Figures 7B and C illustrate the type of physical chemistry reactions that occur at and between the saline solution

Continued

Use of Feeble Electric Currents

Continued

and electrode surface regions with this device. The negative platinum electrode becomes a continuous hydroxyl ion (OH) source from a set of physical chemical reactions represented by Equations 1, 2, and 3.

$Na^+ + e^- \longrightarrow Na$; Equation 1

$Na + H_2O \longrightarrow NaOH + H$; Equation 2

$NaOH \longrightarrow Na^+ + OH^-$; Equation 3

Equation 1 indicates the net result of an electron (e) quantum tunneling (jumping) from the platinum metal surface to the positive potential well of the Na^+ ion in its own water molecule complex only a few atomic diameters away from the platinum metal surface. Equation 2 indicates how the neutral sodium atom formed by the reaction of Equation 1 will quickly react with any nearby water molecule to form sodium hydroxide (NaOH) and a free hydrogen atom. Equation 3 indicates how the sodium hydroxide is very unstable in water and rapidly decomposes into a sodium ion (Na^+) and a hydroxyl ion (OH^-). The sodium ion immediately forms a ion water complex and is drawn back toward the negatively charged metal surface to repeat the reactions of Equations 1, 2, and 3 over again. The negatively charged hydroxyl ion water complex is repelled away from the negative electrode and from other hydroxyl ions. The negative electrode has become a continuous generation source for OH^- ions. Also, hydroxyl ions begin to leave the region of the negative electrode by normal thermal driven diffusion processes.

The sodium ion (Na^+) of Equation 1 could be replaced by a potassium ion (K^+) and achieve the same result. The hydroxyl ion (OH^-) generation can significantly increase the concentration of positive ions in the region around the negative electrode, over that of the initial or normal concentration. The negatively charged hydroxyl ions repel away the negatively charged chlorine ions (Cl^-), but attract in the positively charged ions of the saline solution to "shield" or negate the electric field from their negative charge. If the hydroxyl ions are generated at a high enough rate, then a concentration of hydroxyl ions significantly higher than the initial chlorine ion concentration can be achieved in the region of the negative electrode. Along with this high hydroxyl ion concentration is a comparable increase in the concentration of positive ions of the saline solution in the proximity of the negative electrode to counter the electric field generated by these negatively charged hydroxyl ions. It is therefore this hydroxyl ion generation process directly behind the wound site in Figure 7A which causes the body cells in that region to experience a significant increase in positive metal ions around their outer cell membranes, while at the same time experiencing a increase in PH, and a significant drop in the concentration of negatively charged chlorine ions (Cl^-) outside of their cell membranes.

The positive electrode has an analogous set of ion reactions occurring which offset or balance out the charge displacements occurring at the negative electrode. At the positive electrode silver ions (Ag^+) are going into solution repelling the other positive ions of the saline solution, while at the same time attracting in negatively charged chlorine ions (Cl^-) to balance off or counter the electric field generated by the silver positively charged ions. Chlorine ions recombine at the positive electrode forming chlorine gas (Cl_2) and donating their extra electron to the positively charged silver electrode. Also, minor amounts of molecular oxygen and positive hydrogen ions are being

Continued

Use of Feeble Electric Currents

Continued

generated at the silver electrode surface by the reaction indicated in Equation 4.

$$2\,H_2O \longrightarrow O_2 + 4H^+ + 4e^-; \quad \text{Equation 4}$$

The positive hydrogen ions also draw in negative chlorine ions to shield the electric field generated by the hydrogen ion positive charge.

As is well known from biological research, the type and amount of ion transport across the cell bi-lipid membrane and therefore the concentrations of various ion types inside a cell, controls much of a cell's physiology and genetic activity. All cell membranes have various types of ion channels for each ion type, i.e. Na^+, K^+, Cl^-, Ca^{++}, etc. The various ion concentrations outside the cell lipid membrane strongly influence the ion transport across the cell membrane and therefore the ion concentrations inside the cell and thereby cell physiology and genetic activity.[6,7,8,9,10,11,12,13]

From our above discussion of how hydroxyl ion generation causes higher than normal positive ion concentrations around or in the region of a negative electrode we will now also see how higher than normal positive ion concentrations around a positive electrode can occur. Consider the hydroxyl ion generation process, which will occur in the set up of Figure 6B. Shortly after hydroxyl ion production has started, higher than normal positive metal ion concentration will occur around the negative electrode from the positive ions drawn in by the hydroxyl ion electric field, thereby shielding the hydroxyl ion electric field. The hydroxyl ions will not only keep diffusing away from the negative electrode after their creation, they are also actively being drawn toward the positive electrode. In Figure 6B the lines joining the two electrodes are the electric field lines. These lines represent the path that a negative or positive ion will follow when traveling between the two electrodes, if they initially are located on one of these lines and only the electric field is acting on the ion. The relatively shorter the line also represent where the electric field is relatively the strongest and where the ions therefore travel between the electrodes at the highest "drift" velocity. As the hydroxyl ions are generated at the negative electrode and bring in positive metal ions to shield their electric field, they are also being guided along the field lines of Figure 6B toward the positive electrode. However, the hydroxyl ions bring (drag) much of their positive shielding ions with them. Furthermore, as the hydroxyl ions which were generated on the shortest field lines travel away from the negative electrode toward the positive electrode carrying much of their shielding positive ions with them, other hydroxyl ions along with their positive ion shielding cloud are transported onto the shortest field lines by ion density gradient "pressures". The end or net result is that sort of an expanding plume of hydroxyl ions, along with their positive shielding ions, travel directly to the region of the positive electrode by approximately the shortest path. The cells surrounding the positive electrode thereby also experience a significant increase in the positive ion concentration on the outside of their cell membranes, along with a significant decrease in chlorine ion (Cl^-) concentration from hydroxyl ion repulsion of chlorine ions. These cells (frog blood cells) therefore go through the same changes as the cells at the negative electrode, as was described earlier. The positive hydrogen ions generated at the positive electrode also react with the negative hydroxyl ions to form water. However, the hydrogen ion diffusion velocity is so much greater than that of the hydroxyl ion that it rapidly diffuses out of the positive electrode region, thereby allowing the plume of hydroxyl ions along with its shielding positive ions to be drawn to the immediate vicinity of the positive electrode before the hydroxyl ions and hydrogen ions significantly recombine.

So far I have used simple hand waving qualitative electric field interaction arguments to indicate how significant ion concentration changes can occur around electrodes in saline solution to explain how cells can be effected by feeble direct

Continued

REGROWING AN AMPUTATED FINGER

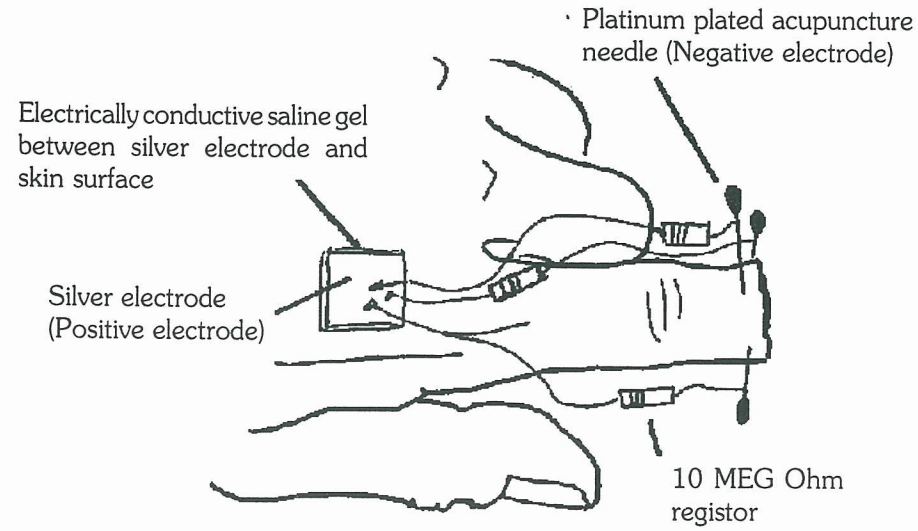


Figure 8

Continued

electric currents. To explain how there is generated a positive metal ion concentration "wave" across the chamber of Figure 6B is too complex and beyond the scope and needs of this article.

Now that we have arrived at a qualitative understanding of how the embryonic looking/primitive dedifferentiated cells needed for blastema formation are created by ionic conditions outside cell membranes, how do we apply this information in a practical way? All that is required is for us to realize we need only scale up the results of the rat experiment of Figure 7A to that of human size. For example, Figure 8 depicts a human finger which has been amputated just above the first knuckle. Platinum plated stainless steel acupuncture needles have been inserted directly behind the amputation site a few days or so after the amputation, or after surgically removing the scar tissue at an old amputation site. It is the ion concentrations that are the missing critical factor. And the ion concentrations required for blastema formation and maintenance should be about the same for all mammals. So, all that is required is to imagine that each acupuncture needle is taking care of one rat arm section and then ask the question: approximately how many rat arm section crossectional areas do we have in this amputated finger crossectional area? That number is how many acupuncture needles are required for the finger. Note that I am using the same electrical circuit used in Figure 7A. That is the contact potential difference between silver and platinum supplies the driving voltage and a high ohmage carbon resistor limits/controls the current flow and therefore the hydroxyl ion generation rate. Becker found that a current in the neighborhood of two hundred nanoamps would work well in rat arm regeneration experiments. Unfortunately, there is a misprint or mistake on the optimal current required for rat forearm regeneration stated on page 152 of Becker's book, *The Body Electric*. It should state two hundred nano-amps not one nano-amp. Reference to the resistance range used (10^6 to 10^8 ohms) when placed into Equation 5 below shows the error. Also reference to the resistance (10 Meg ohms) used in cartilage regeneration experiments discussed on page 189 shows the error. Another reason to expect the current required in living tissue of animals to be much larger than those required in Becker's frog blood cell experiment, of Figure 6A, is that tissue has a blood supply to it. That blood supply system has associated with it the continuous active pressure and diffusion driven transport of blood plasma through the inter-cellular spaces in the damaged tissue region. The hydroxyl ion generation rates are therefore required to be much higher to compensate for the sweeping away/dilution effects of the circulating blood supply in the damaged region.

Since the contact potential difference between silver and platinum is about 2.3 volts* we have from Ohm's Law:

Voltage (V) = Current (I) x Resistance (R); Equation 5

V = 2.3 volts and the required current (I) is 200 x 10^{-9} amps = 2 x 10^{-7} amps

R = V/I = 2.3 volts/2 x 10^{-7}amps = 11.5 x 10^6 ohms.

R is the required resistance to be in series with each acupuncture needle. Note, this R value is right in the middle of the resistance range (10^6 to 10^8 ohms) used by Becker, which was most successful in his rat arm regeneration experiments. Becker would have had complete rat arm regeneration, if he could have had the implant move along with the regrowth on the arm as Smith did in his complete regrowth of an amputated frog limb.[5]

After the blastema has formed and finger regrowth has proceeded about one half a centimeter all of the acupuncture needles should be reinserted into the finger one half a centimeter in the forward direction. In other words the acupuncture needles must be kept relatively close behind the advancing blastema, until full regeneration has been achieved. What we have described here for the finger can be done for the hand, foot, arm, leg, breast, etc. Of course it is necessary to use enough needles evenly spaced apart with care taken to avoid the major nerves, arteries, and veins. As the crossectional area and therefore the thickness of the amputation site become larger and larger, the length of the acupuncture needles must increase to stay at least half the thickness at the amputation site and the current to each needle must increase. The current increase should be such that the current per unit length of the implanted needle remains the same as that used at the original finger amputation site discussed above. By simply changing (lowering) the value of the high ohmage carbon resistors the current can be adjusted to the proper value (a constant current per unit length of implanted needle length). As the regeneration process proceeds the crossectional area of the advancing tissue will decrease. Less total current flow will be required to maintain the proper ionic conditions. Either or both a lessening of the number of needles used or a lowering of the current is desirable. However, when dealing with just a single finger one set of settings should be adequate.

The regeneration of body limbs should currently be common in the practice of medicine. It is not, due to the rampant corruption at the highest levels of medical research funding and, therefore, research control. This fact was alluded to throughout Becker's book, and was discussed in detail in his last chapter — "Postscript: Political Science." This corruption can not be over stated. It is the driving reason behind the high cost, high profit, ineffective (for the patient / victim) allopathic medical system we are currently suffering under. For those of you who are becoming computer literate, there is a Web Site on INTERNET managed by Walter W. Stewart,

*** Post publication note: Value should be more like 1.2 volts, correct calculations accordingly.**

Use of Feeble Electric Currents

Continued

<stewartw@helix.nih.gov> Try: hffp://nyx10.cs.du.edu:8001/~wstewart/ This site contains the complete text of the Dingle Subcommittee Report on fraud and cover-up at the NIH.

In part two, we will look at spinal cord regeneration, implications of ion concentrations outside cell membranes for cancer treatment, and whole body regeneration/rejuvenation in general.

REFERENCES:

1) *The Body Electric* by Robert O. Becker, M.D., and Gary Selden; Published by William Morrow and Company, Inc.

2) Ibid page 59

3) Ibid page 113.

4) Ibid page 143

5) Ibid page 151

6) "Electrogenic Properties of the Na, K Pump" by H. J. Apell, *J. Membrane Biol.* 110. 103-114 (1989)

7) "Activation Kinetics of Single High-Threshold Calcium Channels in the Membrane of Sensory Neurons from Mouse Embryos" by P. G. Kostyuk, Ya. M. Shuba, and V. I. Teslenko, *J. Membrane Biol.* 110. 29 - 38 (1989)

8) "Single Chloride - Selective Channel from Cardiac Sarcoplasmic Reticulum Studied in Planar Lipid Bilayers" by Eric Rousseau, *J. Membrane Biol.* 110. 39 - 47 (1989)

9) "Ca^{2+} - Activated K^+ Channels from Cultured Renal Medullary Thick Ascending Limb Cells: Effects of pH" by Miguel Cornejo, Sandra E. Guggino, and William B. Guggino, *J. Membrane Biol.* 110. 49 - 55 (1989)

10) "Membrane Potential, Anion and Cation Conductances in Ehrlich Ascites Tumor Cells" by Ian Henry Lambert, Else Kay Hoffmann, and Finn Jorgensen, *J. Membrane Biol.* 111. 113 - 132 (1989)

11) "An Essential 'Set' of K^+ Channels Conserved in Flies, Mice and Humans" by Lawrence Salkoff, Keith Baker, Alice Butler, Manuel Covarrubias, Michael D. Pak and Aguan Wei, *Tins*, Vol. 15, No. 5, 1992

12) "Primary Structure and Functional Expression of a Rat G-Protein - Coupled Muscarinic Potassium Channel" by Yoshihiro Kubo, Eitan Reuveny, Paul A. Slesinger, Yuh Nung Jan and Lily Y. Jan, *Nature*, Vol.364, 26 August 1993

13) "The Tips/Tins Lecture: The Molecular Biology of Mammalian Glutamate Receptior Channels" by Peter H. Seeburg, *Tips* — August 1993, Vol. 14

ADDENDUM TO ARTICLE (PART 1) Date: 1/10/11

Dear Acupuncturists and Veterinarians

What is presented here is information that hopefully can and will be used to regrow and replace missing appendages. Would it not be nice if V.A. hospitals were regularly regrowing/replacing all the blown off body parts of our veterans? Would it not be nice if all of our animal friends could be made whole again?

To use and implement the information in the regeneration article (part 1), you need to know the following:

1) The needle shaft (pure platinum plated acupuncture needle) should be kept approximately less than one third of an inch on the back side of the growth front (blastema).
2) A rectangular shaped (pad) piece of gauze or cotton cloth, filled (saturated) with a saline electrically conductive gel is placed between the pure silver plate electrode and the bare skin or shaved hide. The gel pad should be replaced once every few days. The pad should be at least 1/16 of an inch thick. Most ultrasound gels made now are electrically conductive and can be used for the needed gel.
3) The needles should be spaced approximately no more than one third of an inch apart. They must either come very close to the bone or to within one sixth of an inch from the center of the limb or appendage cross section.
4) As a rule of thumb, the number of needles (n) to use is: (3p+1), where p is the numerical value in inches of the length of the closed minimal peripheral path of the needle placement, just behind the growth front (blastema). Round 3p to the nearest whole number.
5) The pure silver plate electrode (not sterling silver), the high ohm resistors, and associated wiring need to be properly taped down to the skin or shaved hide as shown in Figure 1 below. All circuit surfaces except the the silver electrode and platinum electrode are insulated, i.e two coats of finger nail polish on solder joint and metal resistor leads.

Figure 1 in this addendum is a more detailed view of some aspects of Figure 8 in the attached article (part 1). The hidden assumption in Figure 8 is that we know that the finger amputation site cross sectional area is approximately three times that of the rat leg amputation site cross sectional area depicted on page 153 of Becker's book THE BODY ELECTRIC and represented on page 28 as Figure 7A of the attached article (part 1). The successful resistance range (10^6 ohms to 10^8 ohms) used corresponds to a successful current of injury range of 1 to 100 current units. In other words there is a minimum current that is successful in regeneration, say 1 unit, and also 100 times that (100 units) is also successful. Furthermore, all the currents between 1 unit and 100 units are successful in regeneration results. In other words we can be off by a factor of 2 or 3 too small in our estimate of the cross sectional area of the amputation site and still get good regeneration results, as long as we lean towards the higher current values, i.e. 5 to 10 meg ohm resistors used, not 90 to 100 meg ohm resistors used with each electrode (pure platinum plated acupuncture needle).

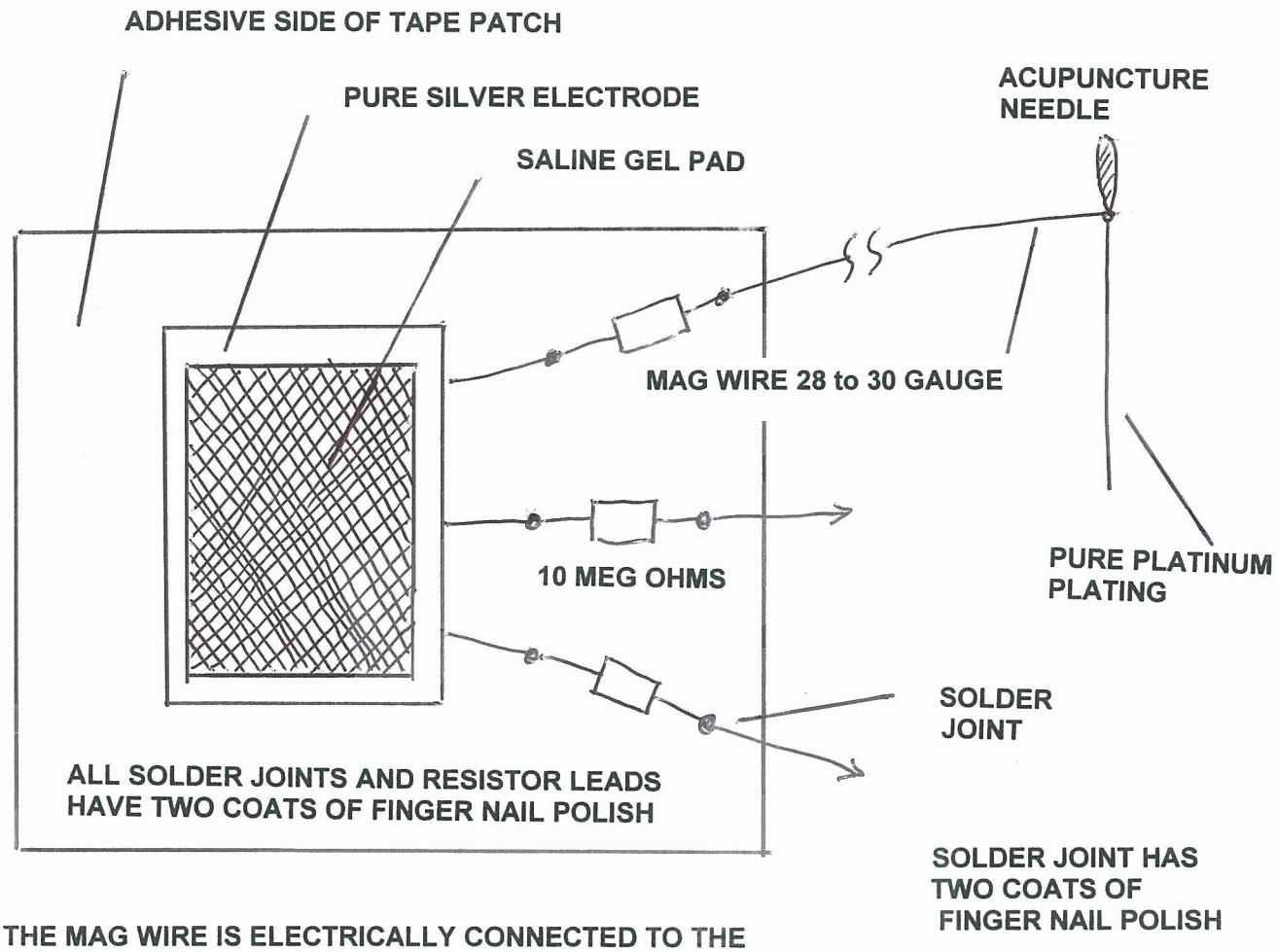
Some Extra Information to Help Understand How Things Work

It is the contact potential difference between two different metals that powers/drives the negative current (hydroxyl ions) generated at the pure platinum plated electrode surface region surrounded by animal flesh. The contact potential difference is equal to the difference between the electron work functions of the two metal electrodes (pure platinum and pure silver). The electron work function of a metal is the amount of energy, usually given in electron volt units, that is necessary to just be able to free/remove an electron from the metal interior and leaving the electron just outside the metal surface. Figure 2 shows two metal blocks, one is pure silver (Ag) and one is pure platinum (Pt) before and after they make contact with each other. The electron density (number/volume) inside pure silver is significantly higher than it is inside pure platinum. The velocity of the electrons in a metal responsible for net current flow in a metal have their velocity proportional to the 3/2 power of the electron density in that metal. This has the consequence that the electrons responsible for net electric current flows in pure

silver travel faster in pure silver than in pure platinum. When the two blocks of silver and platinum are initially placed into contact more electrons with higher velocity impact the interface between the two metal from the silver side then from the platinum side and a net tunneling of electrons into the platinum side occurs, charging the platinum negative and leaving a deficiency of electrons in the silver, making it a positive charge. This process continues until a dynamic equilibrium occurs where equal numbers of electrons per time are going in opposite directions across the metal interface and a constant contact potential difference is established. The technical details of how all of this occurs are too complex for this addendum to cover.

Figure 3 shows a series of several blocks of crystalline conductors in contact. The contact potential difference between the two ends of pure silver and pure platinum are the same as in Figure 2 above as long as the surfaces of the inner blocks are electrically insulated from the rest of the world. It does not matter how many different conductor blocks are in between, as long as they are insulted from the rest of the world, then the two outer most blocks determine the contact potential difference between the two ends. Figure 3 is really our acupuncture needle treatment circuit Figure 1. To see this, look at Figure 4.

FIGURE 1



THE MAG WIRE IS ELECTRICALLY CONNECTED TO THE MIDDLE OF THE BACK OF THE PURE SILVER ELECTRODE, NOT THE EDGE, WITH SILVER ELECTRICALLY CONDUCTIVE EPOXY. NO BARE METAL OTHER THAN THE SILVER ELECTRODE (PLATE) AND THE ACUPUNCTURE NEEDLE ARE TO MAKE ELECTRICAL CONTACT WITH THE SKIN. ALL OTHER METAL IS TO BE INSULATED OR COATED WITH TWO COATS OF FINGER NAIL POLISH.

FIGURE 2

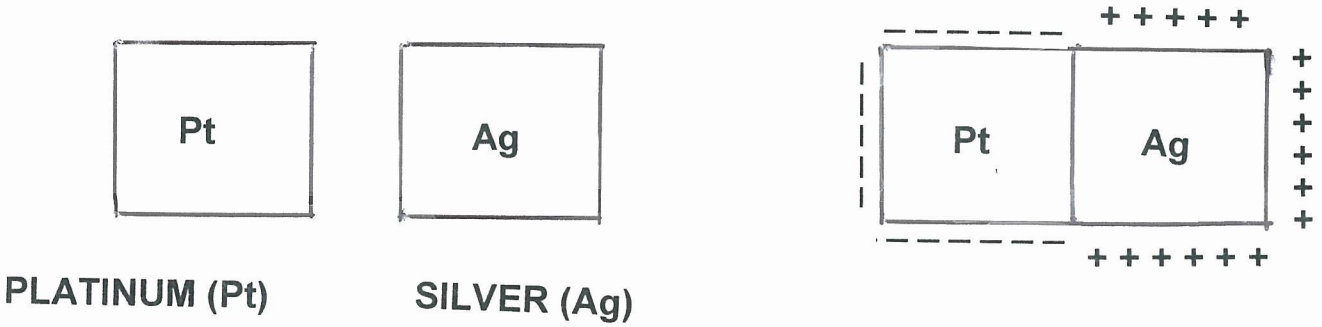


FIGURE 3

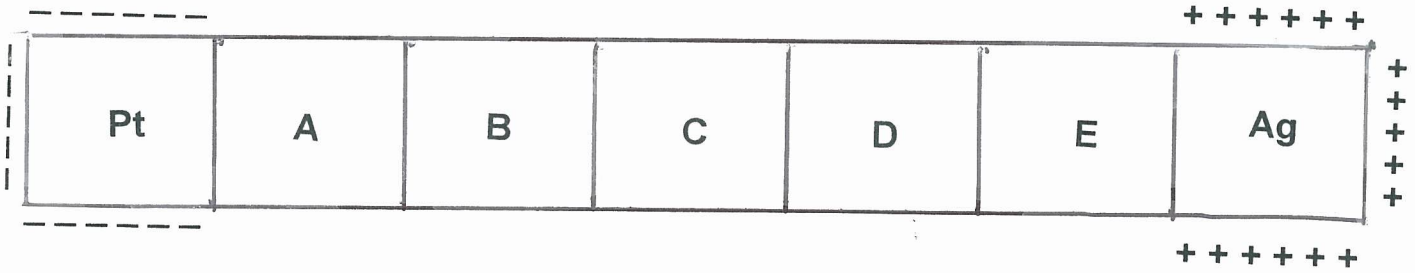


FIGURE 4